

SPARROW model of nutrients in San Joaquin Valley surface waters

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Outline of Presentation

- What is SPARROW
- Applications of SPARROW for California
- SPARROW data sets and calibration
- Nitrogen sources and loads
- Further work and model refinement



What is SPARROW?

- Acronym for: SPAtially-Referenced Regression On Watershed attributes
 - Help understand factors affecting water quality; Simulate water-quality response to climate and land-use change (historical, future);
 - Predict mean-annual flux and yield and concentration for unmonitored stream reaches and watersheds;
 - Apportion stream loads to major nutrient sources and upstream watersheds;
 - Assess effects of hydrological and biogeochemical processes on transport and fate in watersheds;
 - Constituents modeled successfully : Nitrogen, Phosphorus, Suspended Sediment, and Organic Carbon

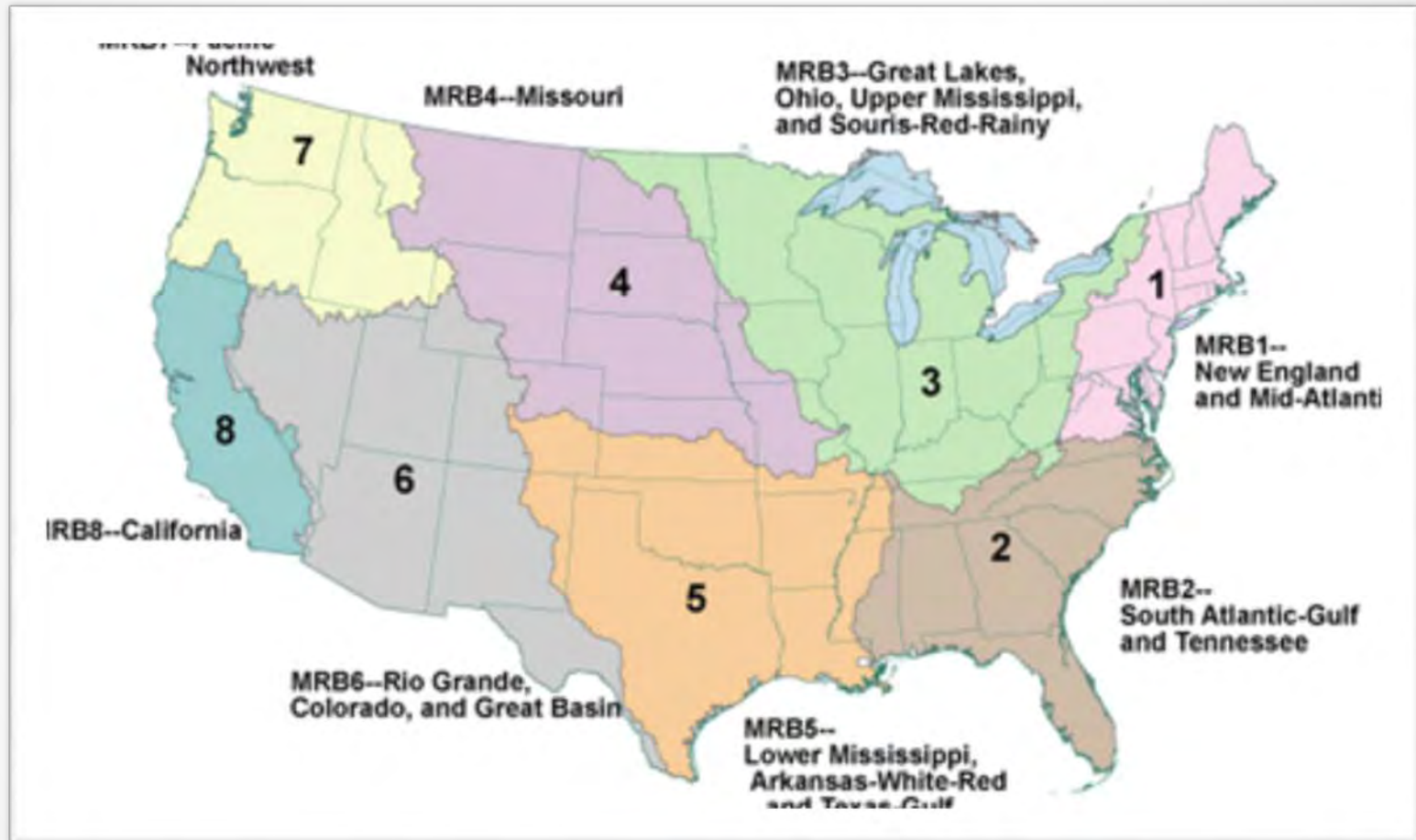
SPARROW Model Mathematical Form

$$F_i^* = \left\{ \left[\sum_{j \in J(i)} F'_j \right] \delta_i A(Z_i^S, Z_i^R; \theta_S, \theta_R) + \left[\sum_{n=1}^{N_S} S_{n,i} \alpha_n D_n(Z_i^D; \theta_D) \right] A'(Z_i^S, Z_i^R; \theta_S, \theta_R) \right\} \varepsilon_i$$

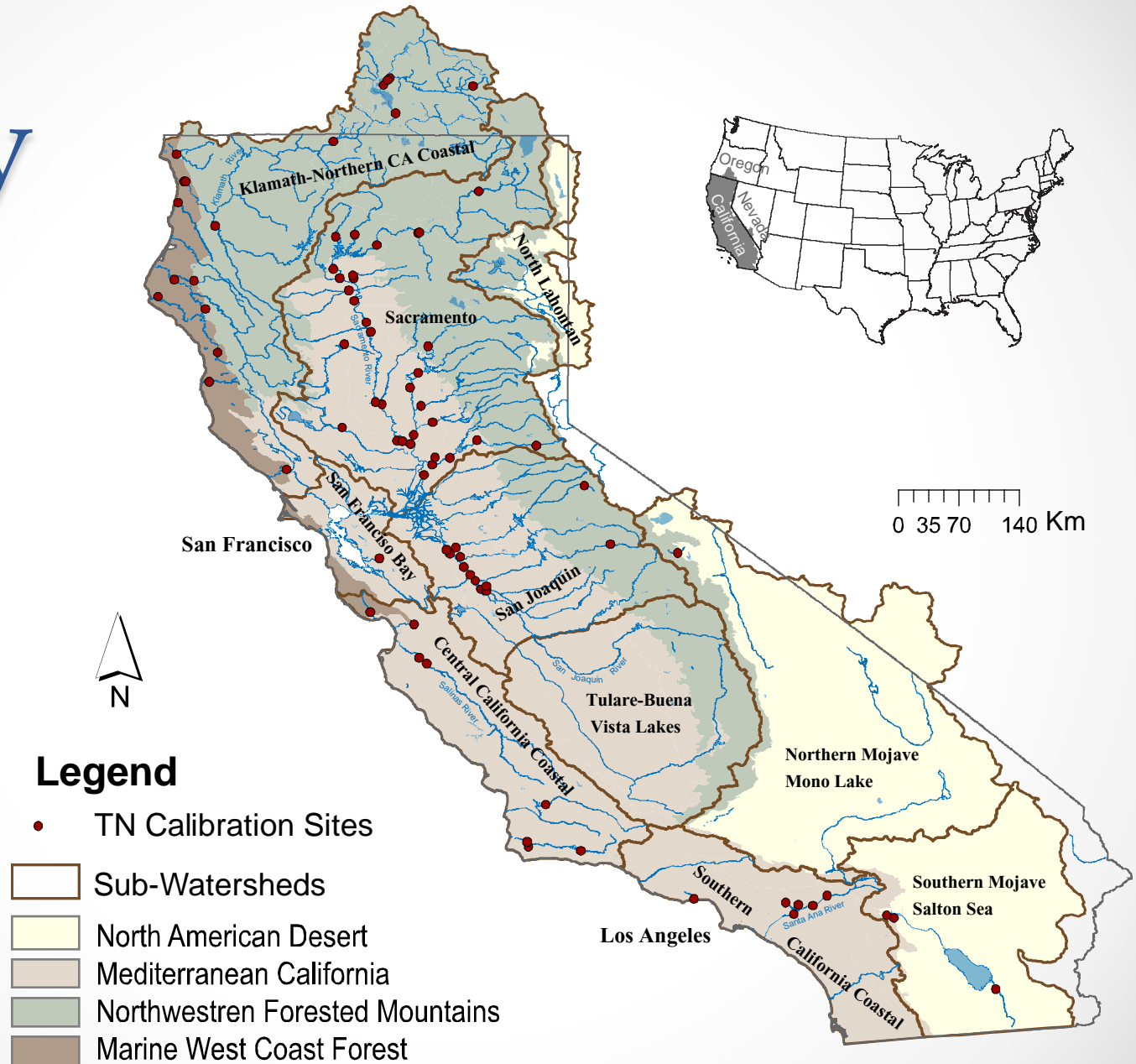
Flux from upstream reaches
Flux sources introduced to the stream network
Land-to-water delivery
Aquatic transport

- All parameters are simultaneously determined to best fit the data.

Developing The SPARROW Model



Study Area



NHDplus

- Scale is 1:100k
- From 30 meter DEM
- Blue lines are streams with defined watersheds (4,564)

SPARROW Data Layers

- Base Flow Index
- Climate: Annual Precipitation, Temperature
- Bedrock Geology
- Surficial Geology
- Hydrologic Landscape Regions
- Population Density
- Nutrient EcoRegions
- NLCD 2001
- 2001 Percent Impervious Surface 2001
- 2001 Percent Canopy
- Mean Annual R-factor, 1971-2000
- Physiography
- STATSGO
- Recharge
- Infiltration Excess Overland Flow
- Saturation Excess Overland Flow
- Atmospheric Deposition
- Normalized Atmospheric Deposition NO₃, NH₄, Total Inorganic N
- Nutrient Inputs from Fertilizer and Manure (N&P)
- Nutrient Application for Fertilizer and Manure Applied to Crops
- Estimated Area of National Resource Inventory Variables: Tile Drains (1992), Ditches (1992) , Total Artificial Drainage (1992) and Irrigated Area (1997)
- Physical Measures, Drainage area, Basin Shape Index, Sinuosity, Slope, Stream Density, Stream Length, Road Density etc
- Average streamflow (in cfs) for the period WY1975 to WY2007 from NHDPlus estimated using the Unit Runoff Method (UROM).

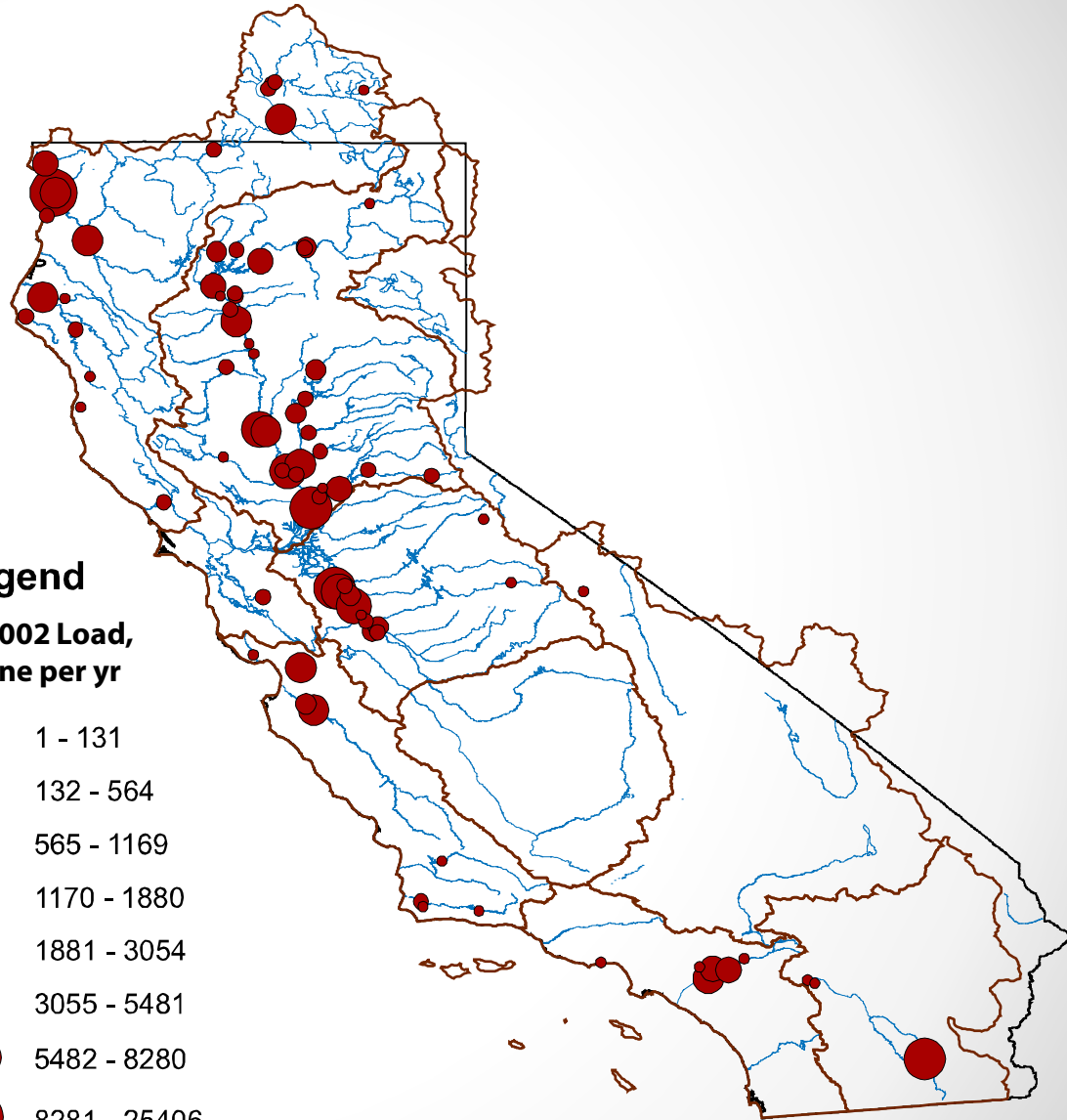
TN Calibration Sites

Calibration Loads
Calculated using
Fluxmaster

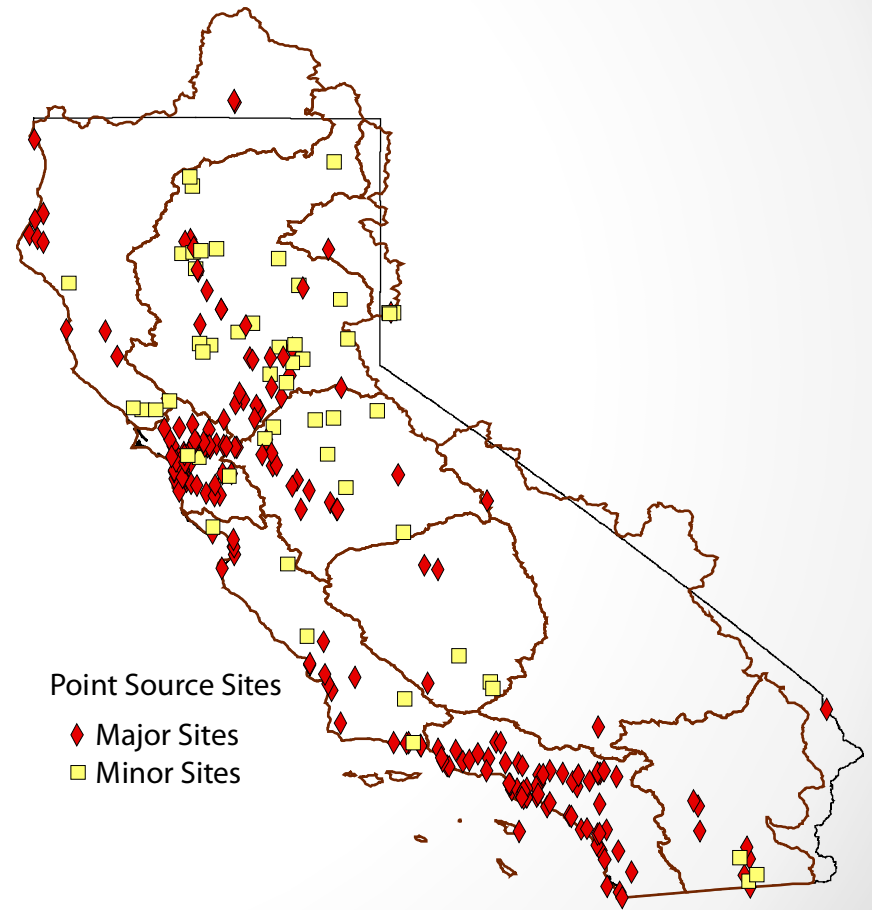
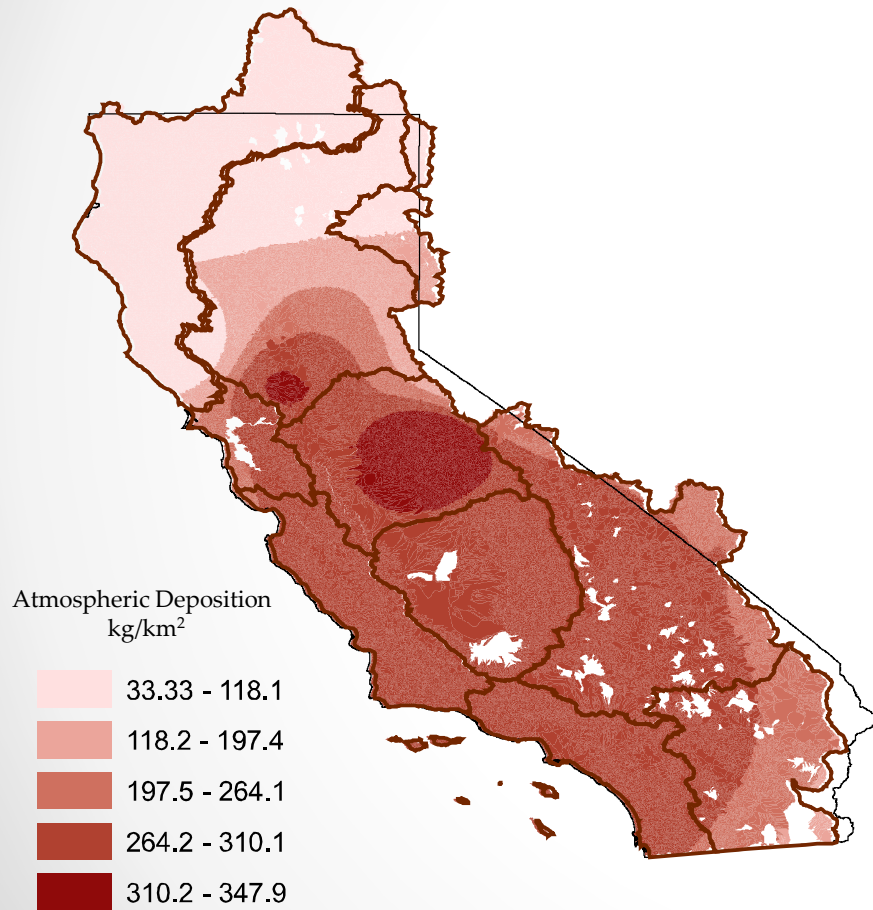
Legend

TN 2002 Load,
in tone per yr

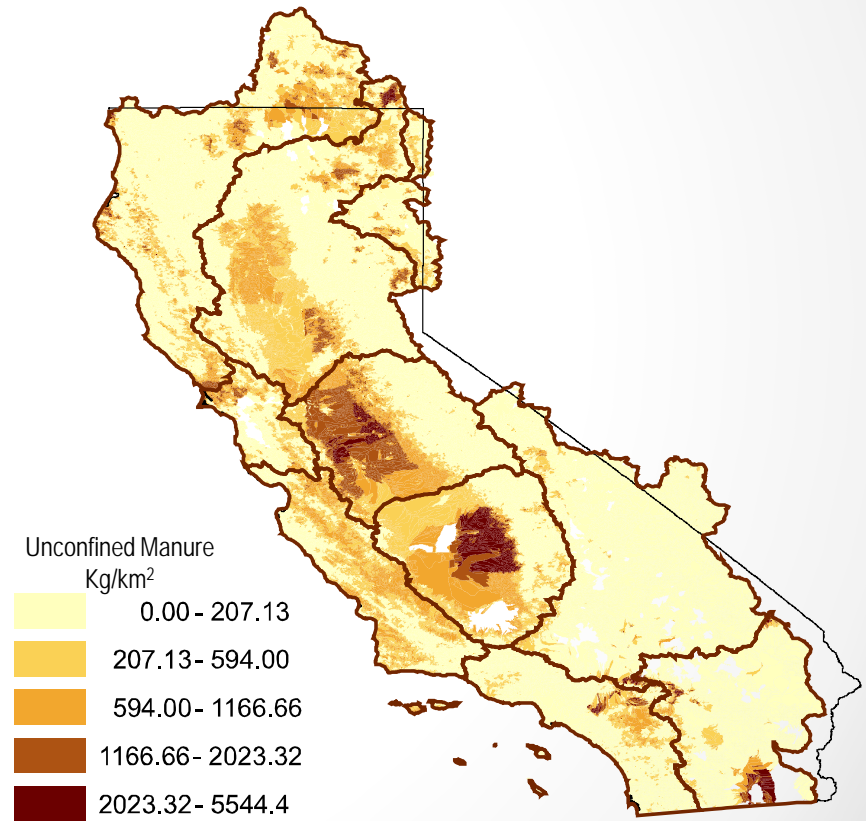
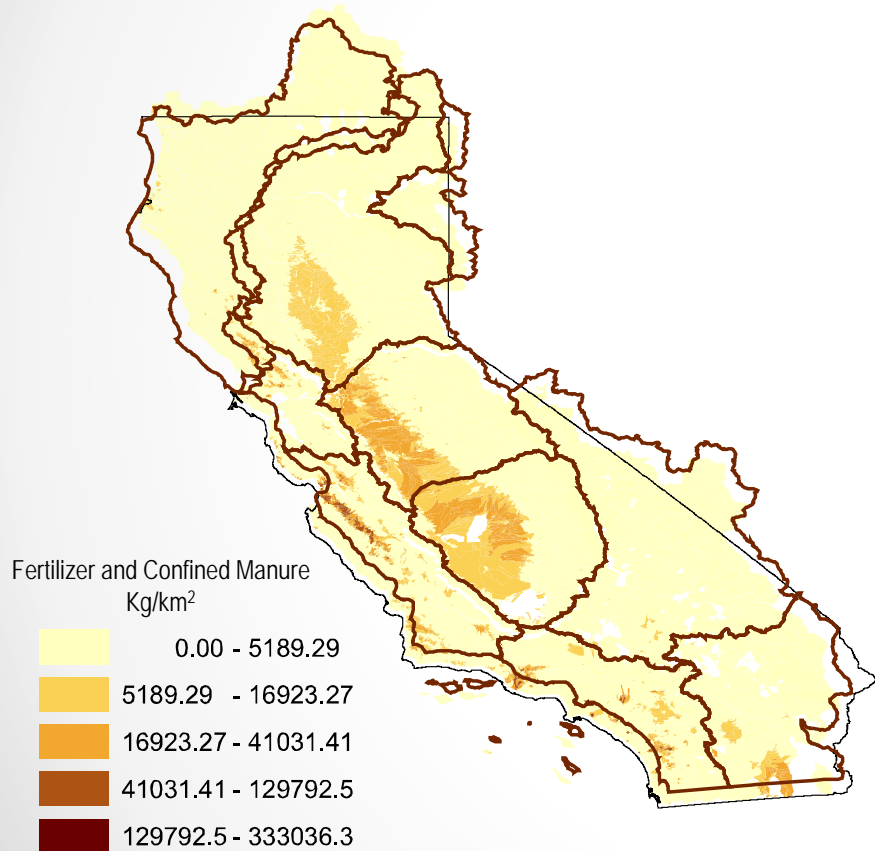
- 1 - 131
- 132 - 564
- 565 - 1169
- 1170 - 1880
- 1881 - 3054
- 3055 - 5481
- 5482 - 8280
- 8281 - 25406



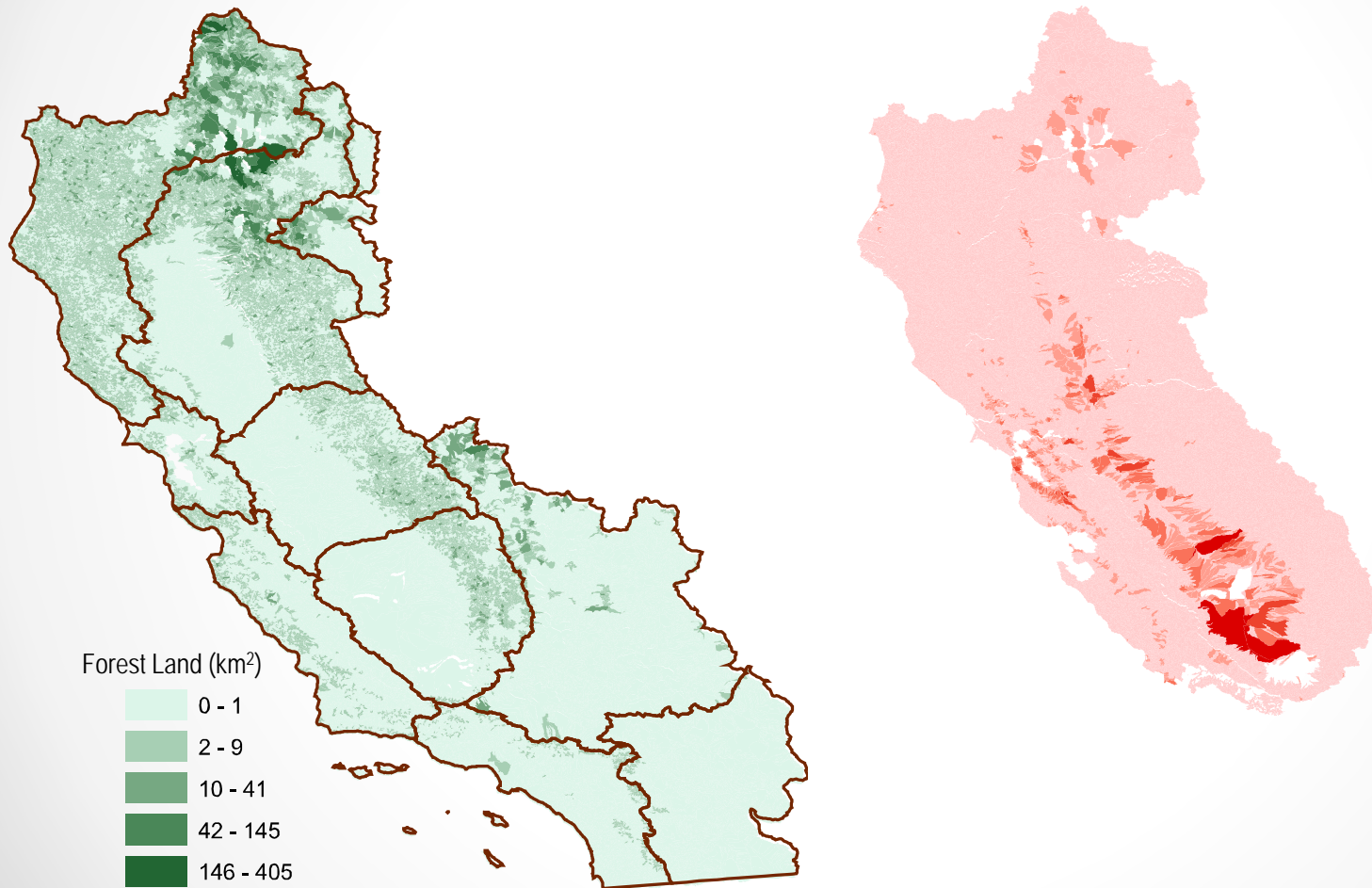
Load Sources



Load Sources



Load Sources

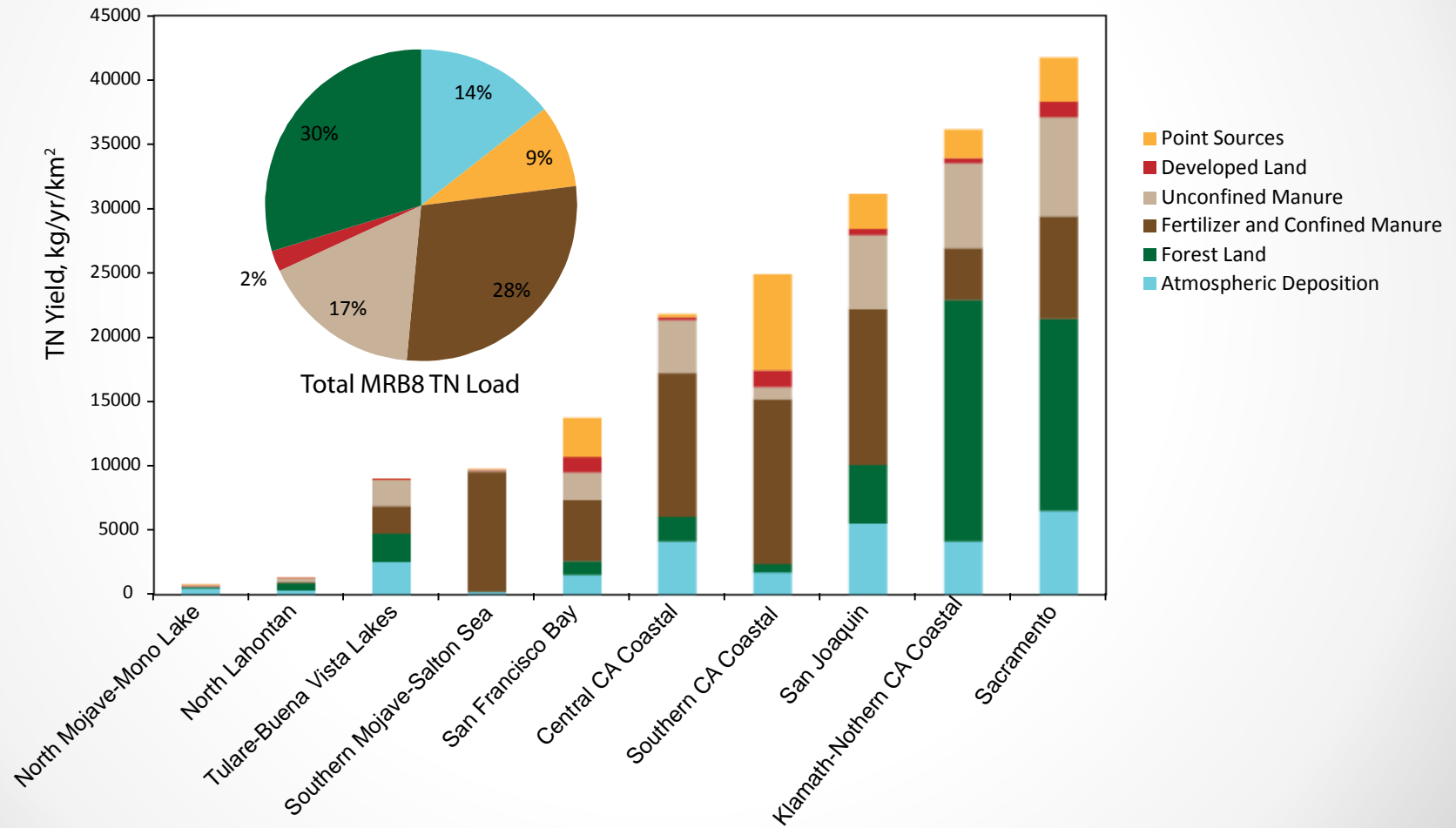


TN SPARROW Model Calibration Results

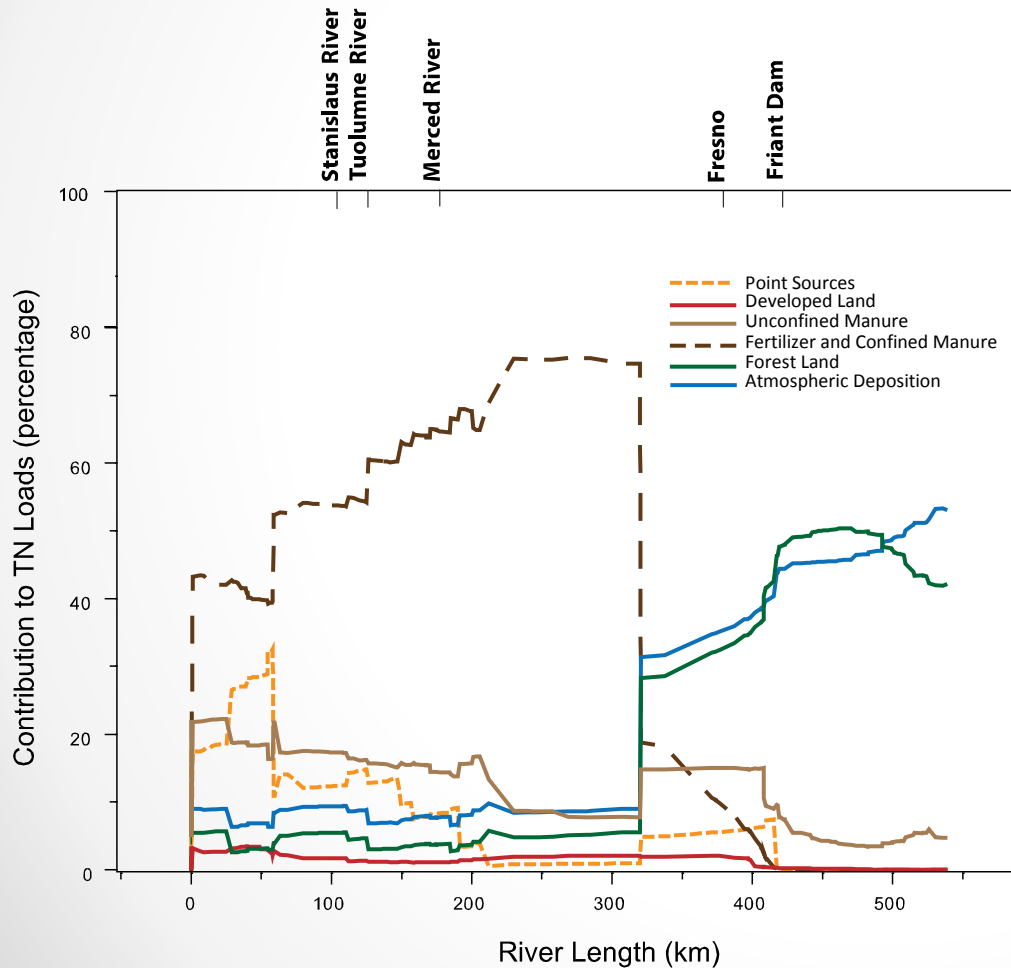
Parameter	Probability level (p-value)
Sources (p < 0.1)	
Atmospheric Deposition (kg/yr)	0.057
Fertilizer and Confined Manure (kg/yr)	0.023
Unconfined Manure (kg/yr)	0.036
Forest Land (km ²)	0.036
Developed Land (km ²)	0.069
Point Sources kg/yr	0.008
Land to Water Delivery (p < 0.05)	
Precipitation (mm)	<0.001
Percent Sand (km ²)	0.046
Percent Wetlands	<0.001
Percent Tile Drains	<0.001
Aquatic Loss (p < 0.05)	
Small Perennial Streams Flow < 500 cfs	< 0.001
Large Perennial Streams Flow > 500 cfs	0.015
Intermittent Streams (cfs)	< 0.001
Model Diagnostics	
R ² /R ² of Yield	0.92/0.78
Number of observations	85

SPARROW Output

SPARROW Output



San Joaquin River Instream TN Loads



Future plans

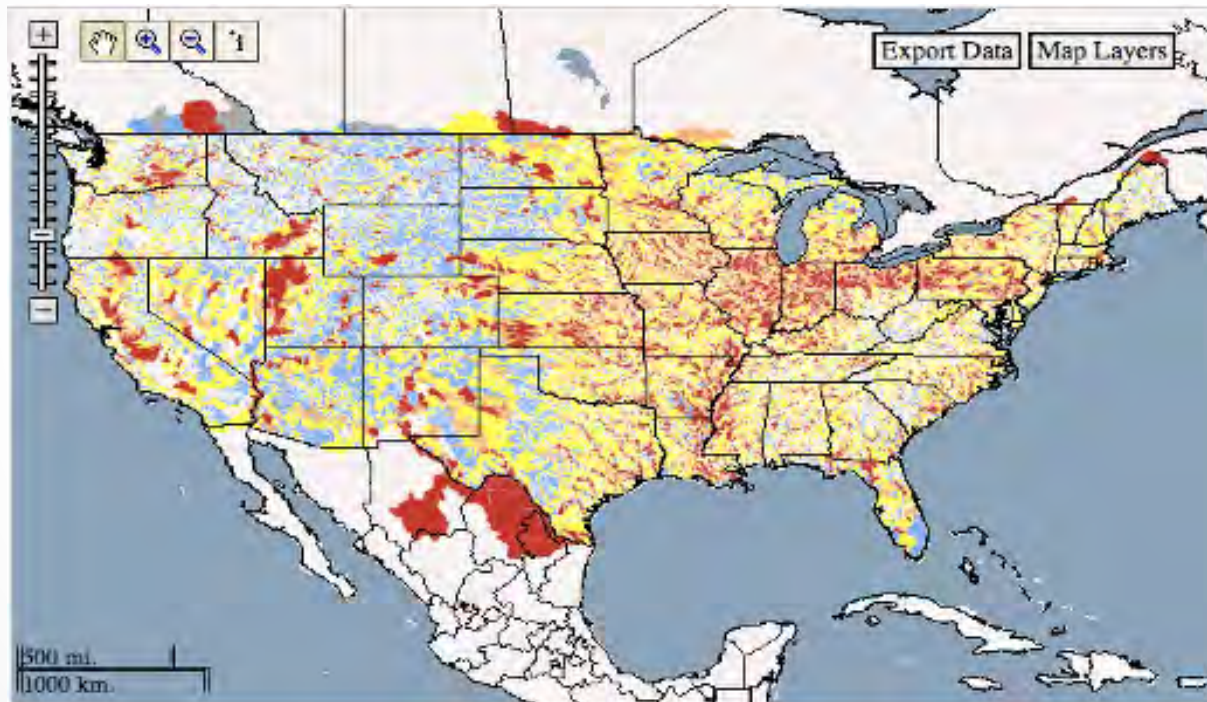
- Interpretations of results (publications)

Future plans

- Interpretations of results (publications)
- Developing the CA SPARROW Decision Support System

SPARROW Decision Support System

Improved transparency and access to the model to inform management decisions



Future plans

- Interpretations of results (publications)
- Developing the CA SPARROW Decision Support System
- Developing a Dynamic SPARROW Model on a small scale for different areas in the MRB8 basin



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Sacramento River Instream TN Loads

